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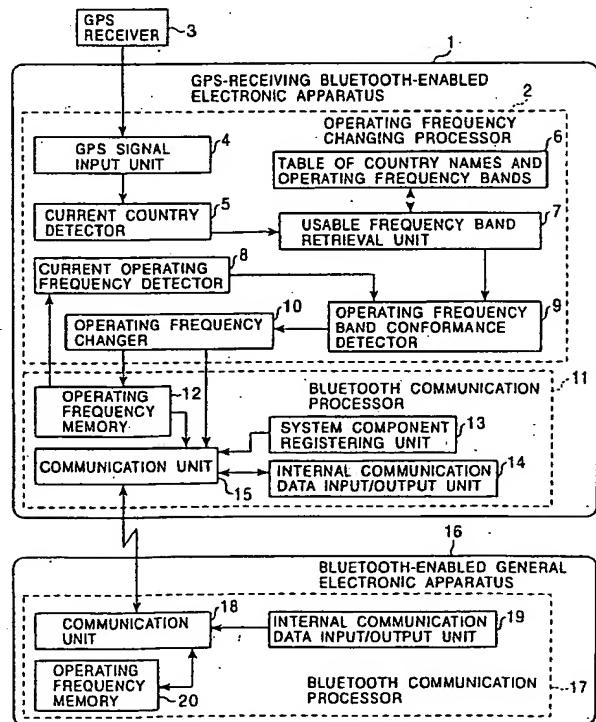
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### (54) Country detection in a wireless communication device

(57) An electronic apparatus (1) with a wireless communication device (2), to which a GPS receiver (3) is connected, detects a current country in which the electronic apparatus is presently located and searches a table (6) for a usable frequency band of the current country. If it is determined that the current operating frequency is inappropriate, the contents of a built-in operating frequency memory (12) are rewritten, thus changing the operating frequency for subsequent use. When another Bluetooth-enabled general electronic apparatus (16) is turned ON, the data is transmitted to the electronic apparatus (16). In response, an operating frequency memory (20) in the electronic apparatus (16) is rewritten, and the frequency is changed for subsequent use.

FIG. 1



ic apparatuses. It is expected that Bluetooth-enabled devices will be widely used and rapidly become popular. For example, an in-vehicle electronic apparatus such as a navigation apparatus can communicate with a cellular phone using Bluetooth. The navigation apparatus obtains navigation-related data or other data from the Internet or displays image data attached to a received email on a monitor television thereof. The Bluetooth technology can be used in various ways. Another in-vehicle electronic apparatus includes an audio apparatus which can receive and record external music data without establishing a cable connection with a cellular phone. The recorded music data can be played or utilized. The navigation apparatus and the audio apparatus can be easily operated by inputting speech to a wireless microphone. Also, signals received by a GPS (global positioning system) receiver can be transmitted wirelessly to the navigation apparatus.

[0009] When Bluetooth becomes widely used in various fields, Bluetooth-enabled apparatuses such as digital still cameras and PDAs which are configured to perform data transmission/reception using Bluetooth may be carried abroad. The use of cellular phones commonly around the world has also been discussed. In such a case, a system containing a Bluetooth-enabled cellular phone and various electronic apparatuses may be taken abroad along with a user. In particular, people of member states of the European Union (EU) can freely travel around the EU countries, and hence these people often use Bluetooth-enabled cellular phones outside their countries. When a vehicle provided with Bluetooth-enabled in-vehicle electronic apparatuses crosses a border into a different country, the Bluetooth-enabled electronic apparatuses also cross the border.

[0010] Bluetooth operates in the 2.4 GHz ISM band without any permission since the ISM band can be freely used. Referring to Fig. 6A, an investigation as of 2000 shows that usable frequencies and a frequency band vary from country to country. Specifically, in the U.S. and many European countries, a frequency band of 83.5 MHz in a frequency range of 2400 MHz to 2483.5 MHz is used. In this frequency band, 79 radio frequency (RF) channels in total are defined every 1 MHz from 2402 MHz. In France, however, a frequency band of 36 MHz is used in a frequency range of 2446.5 MHz to 2483.5 MHz. In this frequency band, 23 RF channels in total are defined every 1 MHz from 2454 MHz.

[0011] As described above, it is expected that Bluetooth-enabled electronic apparatuses will be widely used around the world. In contrast, it is difficult to immediately change the conventional radio-wave allocation due to various circumstances such as military communication of many countries including those not shown in Fig. 6A. It is impossible to standardize the radio-wave allocation around the world at the same time. Standardization is expected to be gradually achieved. Depending on how widely Bluetooth is used, it is unlikely that operating frequency bands and operating RF channel fre-

quencies will accurately coincide with one another for some time.

[0012] When a user with a Bluetooth-enabled electronic apparatus travels abroad, the user is required to change the operating radio-wave of the Bluetooth-enabled electronic apparatus if a country which the user enters has a radio-wave allocation control differing from the previous country. To this end, the electronic apparatus must be provided in advance with an operating frequency adjuster. Using the operating frequency adjuster, the user adjusts the frequency to that of the country entered. The user is required to refer to a frequency allocation table which differs according to each country and to perform adjustment. This is burdensome work for the user. In order to relieve this burden, a table showing countries' operating frequency bands is installed in advance in the electronic apparatus. The table is displayed on a display or the like, and the user looks at the table and makes a selection. Even in this case, the user must perform a burdensome task of setting selection every time the user crosses a border.

[0013] Concerning wireless data communication among various electronic apparatuses, Japan is considering making the 5.2 GHz band or the 5.3 GHz band open to public use in the future. As communication technologies progress and utilization of radio waves changes in the future, there is a trend toward partial liberation from utilization limitation. This is not only the case with Japan, but also with other countries. In the course of liberation of operating radio frequency bands, at first each country liberates its own band, which is followed by international standardization in accordance with radio-wave utilization. Problems similar to the foregoing problem with Bluetooth, which is caused by differences among different countries in using the 2.4 GHz band, are very likely to occur in a wide variety of frequency bands.

[0014] Accordingly, it is an object of the present invention to provide an electronic apparatus with a wireless communication device which implements wireless data communication using Bluetooth with various other electronic apparatuses, whereby it becomes unnecessary to adjust the operating frequency every time the electronic apparatus crosses a border although different countries have different usable frequency bands.

[0015] According to the present invention, the foregoing objects are achieved through provision of an electronic apparatus with a wireless communication device. The electronic apparatus includes the wireless communication device including a GPS signal input unit for inputting a GPS signal; a current country detecting unit for detecting a current country in which the electronic apparatus is presently located based on the GPS signal; a usable frequency band retrieval unit for retrieving a usable frequency band of the current country based on country name data from the current country detecting unit and data on a table of country names and operating frequency bands; and an operating frequency changing

the frequency is automatically changed without performing a special operation.

[0031] According to the present invention, a table of country names and operating frequency bands can be externally rewritten through the communication unit. The most recent external information is input through the communication unit in order to change the operating frequency band of each country, which is expected to change from year to year. Accordingly, the table of country names and operating frequency bands can be rewritten. It is thus possible to appropriately change the frequency based on the most recent data.

[0032] An embodiment of the present invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Fig. 1 is a block diagram of a GPS-receiving Bluetooth-enabled electronic apparatus and a Bluetooth-enabled general electronic apparatus for communicating with the former electronic apparatus;

Fig. 2 schematically illustrates the configuration of a system containing a cellular phone, a PDA, and a digital still camera which are linked with one another using Bluetooth;

Fig. 3 is a flowchart showing an operating frequency changing process performed by the GPS-receiving Bluetooth-enabled electronic apparatus in this embodiment;

Fig. 4 is a flowchart showing a process of changing the operating frequency of a Bluetooth-linked, registered apparatus;

Fig. 5 is a flowchart showing a process of setting the frequency of the Bluetooth-linked, registered apparatus;

Figs. 6A to 6C are tables showing actual Bluetooth data, which include the following: Fig. 6A is a table showing the Bluetooth limited frequency bands and RF channels; Fig. 6B is a table showing a Read Country Code command and return parameters thereof; and Fig. 6C includes tables showing the return parameters; and

Fig. 7 is a block diagram of a communication system forming an in-vehicle communication system using Bluetooth according to the present invention.

[0033] The present invention will become apparent from the following description of the preferred embodiments with reference to the accompanying drawings. Fig. 2 shows an example of the use of Bluetooth-enabled electronic apparatuses according to the present invention. In this example, a cellular phone 21, a digital camera 22, and a PDA, a hand-held PC, or a notebook PC (hereinafter referred to as a "PDA") 23 are used. Each of the apparatuses 21 to 23 is provided with a Bluetooth-enabled communication device which operates in the 2.4 GHz ISM band. Arranged as described above, an image captured by the digital camera 22 is transmit-

ted to the cellular phone 21 using Bluetooth, and the cellular phone 21 in turn transfers the image to a predetermined destination using email. The image data can also be transmitted to the PDA 23 using Bluetooth, and hence many pieces of image data can be stored in the PDA 23. File management and data manipulation can be performed. If necessary, data in the PDA 23 is transmitted to the cellular phone 21, and the cellular phone 21 transmits the data to a remote place using email. Internet information received by the cellular phone 21 is transmitted to the PDA 23 using Bluetooth, thus displaying the information.

[0034] Among these Bluetooth-enabled electronic apparatuses, the PDA 23 stores map data in advance. As shown in Fig. 2, since the PDA 23 is provided with a GPS receiver 24, the PDA 23 can receive GPS signals. Using the GPS-reception signals and the map data, the current location can be detected. The map data can be utilized by storing in advance commercial map display software data. Alternatively, it is only necessary to store data on borders in order to retrieve Bluetooth operating frequencies as in the present invention described hereinafter. The GPS receiver 24 can be directly connected to the PDA 23. If the GPS receiver 24 is a type which can only be connected using cable, the GPS receiver 24 can be connected to the PDA 23 by cable. If the GPS receiver 24 has a built-in Bluetooth data communication device, the built-in unit is used instead.

[0035] In a system containing various electronic apparatuses which are linked with one another by Bluetooth for wireless data transfer, as in the PDA 23 shown in Fig. 2, a GPS receiver is connected to an electronic apparatus so that the electronic apparatus can detect a country at the current location. Referring to Fig. 1, this electronic apparatus is shown as a GPS-receiving Bluetooth-enabled electronic apparatus 1. Various types of apparatuses such as the PDA 23 or an in-vehicle navigation apparatus can be used as the GPS-receiving Bluetooth-enabled electronic apparatus 1 as long as they can process signals from the GPS receiver and map data.

[0036] In Fig. 1, a Bluetooth-enabled electronic apparatus which has no GPS receiver connected thereto is shown as a Bluetooth-enabled general electronic apparatus 16. Although a case in which the cellular phone 21 or the digital camera 22 is used as the Bluetooth-enabled general electronic apparatus 16 has been shown in Fig. 2, various electronic apparatuses such as an audio apparatus can be used using a similar system.

[0037] In the example shown in Fig. 1, an operating frequency changing processor 2 is provided in the GPS-receiving Bluetooth-enabled electronic apparatus 1. A GPS receiver 3 which is connected to the Bluetooth-enabled GPS receiving electronic apparatus 1 inputs a current location signal using GPS to a built-in GPS signal input unit 4. Although an example has been described in which the GPS receiver 3 is connected to the GPS-receiving Bluetooth-enabled electronic apparatus 1, al-

paratus 16 which communicates with the GPS-receiving Bluetooth-enabled electronic apparatus 1 contains a Bluetooth communication processor 17 which has substantially the same structure as that of the Bluetooth communication processor 11. Similarly, the Bluetooth communication processor 17 contains therein a communication unit 18, an internal communication data input/output unit 19, and an operating frequency memory 20. The communication unit 18 exchanges internal communication data through the internal communication data input/output unit 19 at a frequency recorded in the operating frequency memory 20. In response to a frequency changing instruction signal from the GPS-receiving Bluetooth-enabled electronic apparatus 1 through the communication unit 18, the contents of the operating frequency memory 20 are changed to the frequency instructed.

[0047] The frequency is changed when the Bluetooth-enabled general electronic apparatus 16 which is turned ON receives an instruction signal to change the operating frequency. Alternatively, it is possible to set the Bluetooth-enabled general electronic apparatus 16 in the following manner. In a normal state, the Bluetooth-enabled general electronic apparatus 16 which is turned OFF is in communication standby mode. In response to a power-ON signal from the master electronic apparatus, i.e., the GPS-receiving Bluetooth-enabled electronic apparatus 1 which has the GPS receiver 3, the Bluetooth-enabled general electronic apparatus 16 temporarily starts operating. The Bluetooth-enabled general electronic apparatus 16 changes the operating frequency and subsequently is turned OFF.

[0048] If an electronic apparatus which performs Bluetooth communication enters a country which uses a different usable frequency band, the electronic apparatus can automatically communicate in the frequency band of that country. However, in the event of a failure to automatically change the frequency band, the electronic apparatus can be provided with an external selector switch or a function button which can be selected, thus allowing the frequency band of the electronic apparatus to be manually changed if necessary.

[0049] The electronic apparatus containing the above-described functional blocks operates in an operation flow as shown in Figs. 3 to 5. Specifically, Fig. 3 shows a process performed by the GPS-receiving Bluetooth-enabled electronic apparatus 1 shown in Fig. 1, such as the PDA 24 shown in Fig. 2. If the electronic apparatus is turned ON (step S1), the process detects the current country in which the electronic apparatus is presently located using a GPS-reception signal (step S2). The process searches for the operating frequency band of the detected country (step S3). The retrieval process is performed by the usable frequency band retrieval unit 7.

[0050] The process detects the current operating frequency (step S4) and determines whether the current operating frequency conforms to the operating frequen-

cy band of the current country (step S5). The determination is performed by the operating frequency band conformance detector 9 shown in Fig. 1. If the determination is negative, the operating frequency memory is changed (step S12). If the determination is affirmative, no particular processing is performed, and the process changes the operating frequency of a Bluetooth-linked, registered apparatus (step S6). Specifically, the process checks whether the operating frequency of another Bluetooth-linked general electronic apparatus is appropriate. When the operating frequency is inappropriate, the process changes the operating frequency to the appropriate frequency. The detailed process is described in Fig. 4 hereinafter.

[0051] After performing a predetermined operation for the electronic apparatus which is turned ON, the electronic apparatus remains in the normal operating state. In the normal operating state, the process determines whether the electronic apparatus which is being used crosses a border using a GPS signal at appropriate time intervals (step S7). If it is determined that the electronic apparatus has not yet crossed a border, the process is periodically repeated until the electronic apparatus crosses a border. If it is determined that the electronic apparatus has crossed a border, the process detects the country entered using the GPS signal (step S8). The process searches for the operating frequency band of the detected country as in step S3 (step S9) and outputs an instruction to the operating frequency memory 12 (Fig. 1) to change the frequency to the retrieved operating frequency band (step S10). The process determines whether the electronic apparatus is turned OFF (step S11). If the electronic apparatus is not turned OFF, the process returns to step S6 and changes the operating frequency of the Bluetooth-linked, registered electronic apparatus, as shown in Fig. 4, and similar processing is repeated. If it is determined in step S11 that the electronic apparatus is turned OFF, the operation flow is terminated (step S13).

[0052] Fig. 4 shows a process of changing the operating frequency of the Bluetooth-linked, registered electronic apparatus. The process detects the power-ON state of each of linked, registered electronic apparatuses in order of registration (step S21). Based on the detection result in step S21, the process determines whether the linked, registered electronic apparatus is turned ON (step S22). If the electronic apparatus is not turned ON, the process returns to step S21 and detects the power-ON state of the subsequently-registered linked electronic apparatus.

[0053] In order to perform detection, the GPS-receiving Bluetooth-enabled electronic apparatus 1 outputs a predetermined signal for checking the power-ON state. The process can detect that the electronic apparatus is turned ON when the electronic apparatus receives the predetermined signal and transmits a predetermined response signal. If it is determined in step S22 that the electronic apparatus is turned ON, the process checks

[0061] Since Bluetooth can be used in various manners by in-vehicle electronic apparatuses, it is expected that Bluetooth will be widely used in the future. The necessity of manually changing the frequency bands of many electronic apparatuses may arise whenever the vehicle crosses a border. The present invention removes this necessity. Thus, the present invention can be simply applied by providing each electronic apparatus with means for changing a frequency memory by external communication.

[0062] In this embodiment, a case in which an electronic apparatus with a GPS receiver, the electronic apparatus functioning as a master electronic apparatus in a Bluetooth communication system, controls the operating frequency band has been described. When a notebook PC and a small PDA, both of which include GPS receiving functions and map data, are used, each apparatus can automatically control its own operating frequency band. If a GPS receiver is miniaturized in the future, thus allowing country border data or the like to be recorded in a chip, many Bluetooth electronic apparatuses can contain therein the GPS receiver and the chip. In such a case, each electronic apparatus can control its own operating frequency band.

[0063] In this embodiment, a case in which the Bluetooth system is used as means of wireless data communication among electronic apparatuses has been described. As described above, it has been considered making the 5.2 GHz band or the 5.3 GHz band open to public use in the future. The range of freely usable radio waves is expanding since radio resources are being made open to the public. In the meantime, the operating frequency bands of countries will be gradually standardized over an extended time period. A similar problem occurs when the above-described electronic apparatuses cross a border and are used. In such a case, automatic frequency changing means using GPS according to the present invention is utilized, thus allowing a user to use the electronic apparatuses without being concerned about differences in the operating frequency bands of different countries.

## Claims

1. An electronic apparatus (1) with a wireless communication device (2), comprising:

the wireless communication device (2) comprising:

- a GPS signal input unit (4) for inputting a GPS signal;
- a current country detecting unit (5) for detecting a current country in which the electronic apparatus (1) is presently located based on the GPS signal;
- a usable frequency band retrieval unit (7)

for retrieving a usable frequency band of the current country based on country name data from the current country detecting unit (5) and data on a table of country names and operating frequency bands (6); and an operating frequency changing unit (10) for changing the frequency for inter-electronic-apparatus communication based on the retrieval result obtained by the usable frequency band retrieval unit (7).

2. An electronic apparatus (1) with a wireless communication device (2) according to Claim 1, wherein the operating frequency changing unit (10) transmits data on the usable frequency band of the current country through a communication unit (11) to an operating frequency changing unit of another electronic apparatus with a wireless communication device.
3. An electronic apparatus (1) with a wireless communication device (2) according to Claim 1, wherein the operating frequency changing unit (10) outputs an instruction to change the frequency to the usable frequency band of the current country through a communication unit (11) to an operating frequency changing unit of another electronic apparatus with a wireless communication device, the other electronic apparatus being registered in a system component registering unit (13).
4. An electronic apparatus (1) with a wireless communication device (2) according to Claim 3, wherein, when it is determined that the frequency of radio waves output by the other electronic apparatus does not correspond to the usable frequency band of the current country, the operating frequency changing unit (10) outputs an instruction to change the frequency to the usable frequency band of the current country through the communication unit (11) to the other electronic apparatus with the wireless communication device, the other electronic apparatus being registered in the system component registering unit (13).
5. An electronic apparatus (1) with a wireless communication device (2) according to Claim 1 or 2, wherein:  
the current country detecting unit (5) determines whether the electronic apparatus (1) crosses a border; and when it is determined that the electronic apparatus (1) crosses a border, the current country detecting unit (5) detects the country entered using the GPS signal.
6. An electronic apparatus (1) with a wireless commu-

FIG. 1

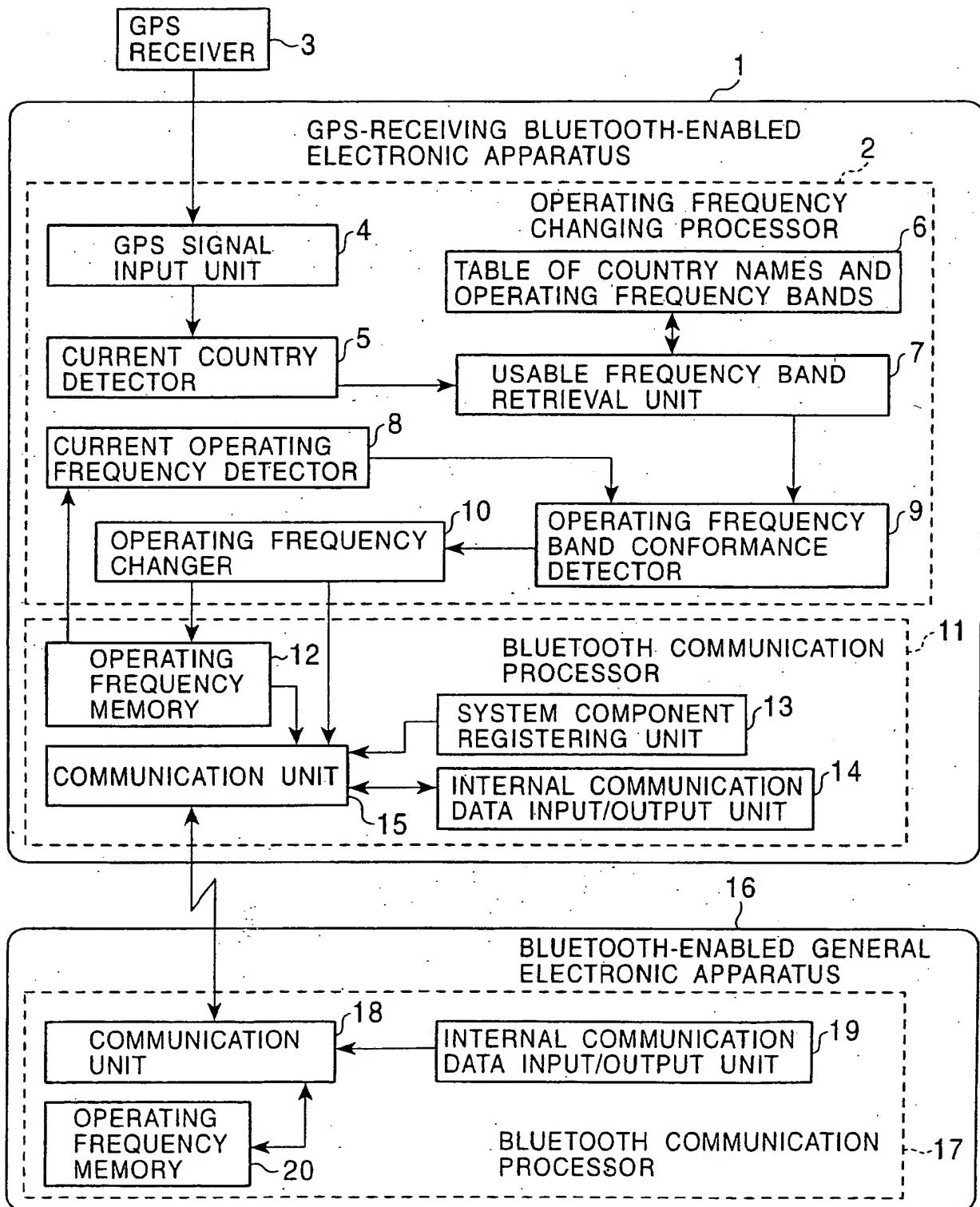


FIG. 3

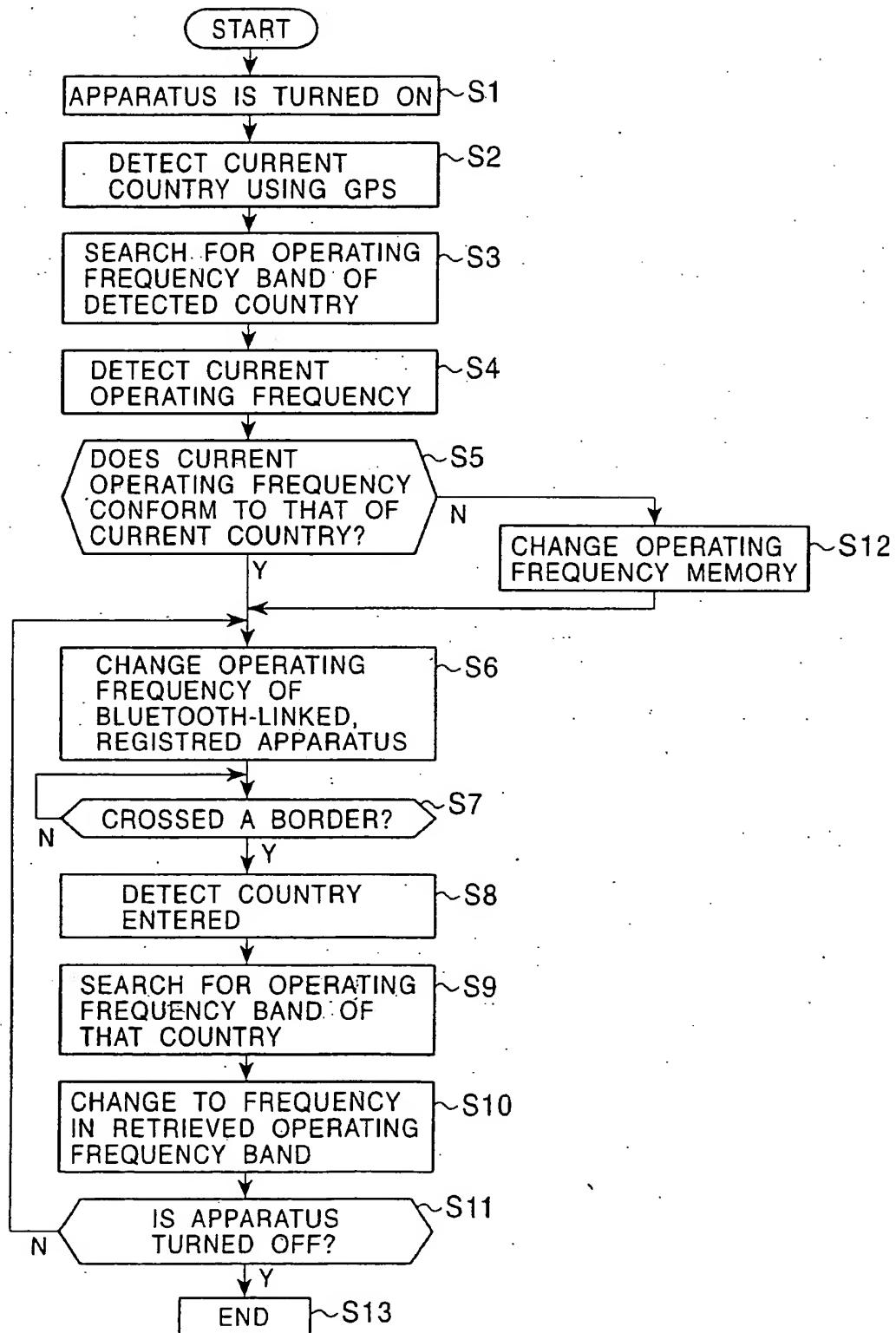


FIG. 6A

REGION	LIMITED FREQUENCY BAND	RF CHANNEL
US, EUROPE (EXCLUDING BELOW), AND MANY OTHER COUNTRIES	2.400 - 2.4835 GHz	$f = 2402 + k \text{ MHz}$ $k = 0, \dots, 78$
FRANCE	2.4465 - 2.4835 GHz	$f = 2454 + k \text{ MHz}$ $k = 0, \dots, 22$

AS OF 2000

FIG. 6B

COMMAND	OCF	RETURN PARAMETER
HCT Read Country Code	0x0007	Status Country Code

FIG. 6C

( i ) Status

VALUE	DESCRIPTION OF PARAMETER
0x00	Read Country Code COMMAND SUCCEEDED
0x01-0xFF	Read Country Code COMMAND FAILED. REFER TO TABLE 6.1 ON P.745 FOR ERROR CODE LIST

( ii ) Country Code

VALUE	DESCRIPTION OF PARAMETER
0x00	US AND EUROPE
0x01	FRANCE
0x02	SPAIN
0x03	JAPAN
0x04-FF	RESERVED FOR FUTURE USE